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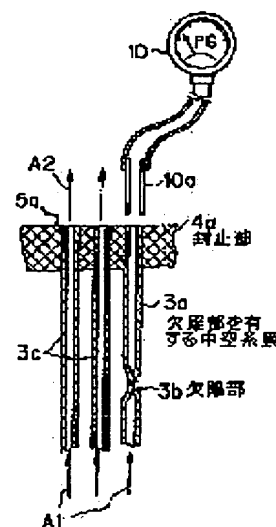
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(54) METHOD FOR INSPECTING HOLLOW-FIBER MEMBRANE AND METHOD FOR INSPECTING HOLLOW-FIBER MEMBRANE MODULE

(57)Abstract:

PROBLEM TO BE SOLVED: To surely detect a hollow-fiber membrane having an involved defect incapable of being detected by a hydrostatic inspection with a simple structure in a short time.

SOLUTION: A hollow-fiber membrane is inspected as follows: the peripheral surface of a hollow-fiber membrane 3a having a defective part is pressurized to crush the defective part 3b to close the inner-diameter passage, a fluid is supplied into the inner-diameter passage of the membrane from its open end, the fluid passing through the inner-diameter passage is detected at the other open end, and the membrane without the fluid being detected is specified as a membrane having a defective part.



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CLAIMS

[Claim(s)]

[Claim 1] The inspection approach of the hollow fiber characterized by specifying the hollow fiber by which pressurize the periphery front face of the film of a hollow fiber, crush a membranous defective part, and membranous bore passage is made to blockade, a fluid is supplied to the bore passage of a hollow fiber from one opening edge of said hollow fiber, the fluid which passed through said bore passage in the opening edge of another side is detected, and a fluid is not detected as that to which a defective part exists in the film.

[Claim 2] In the inspection approach of the hollow fiber module equipped with the closure section closed where it loaded with the bundle of a hollow fiber into the tubed case and opening of the terminal of the bundle of a hollow fiber is carried out in case both ends Pressurize said interior of a case, crush the defective part of a hollow fiber, and membranous bore passage is made to blockade. A fluid is supplied to a hollow fiber from one closure section of said hollow fiber module. The inspection approach of the hollow fiber module characterized by detecting the part of said closure section where the fluid which passed said hollow fiber in the closure section of another side is detected, and a fluid is not detected as a location of the opening terminal of a hollow fiber with which a defective part exists.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the method of detecting the defect of a hollow fiber, and the method of detecting the defect of a hollow fiber module in which it loaded with the bundle of a hollow fiber into the case.

[0002]

[Description of the Prior Art] the hollow fiber of the a large number book a book be inserted into a case be conventionally close with encapsulant , where opening of the terminal of each hollow fiber be carry out in case opening , the closure section be form , and the hollow fiber module which filter the quality (a particle component) of a removal object which isolate the interior of a case and the exterior by this closure section , and be intermingle in the fluid for filtration which supply with the film of a hollow fiber , and remove it be know .

[0003] By such hollow fiber module, it is used for manufacture of pure water, sterilization and turbidity reduction of service water, waste water treatment, or oily water separation, for example, and even the minute leak by the defect of a hollow fiber, damage (a pinhole, a crack, or cutting), etc. may have fatal effect on the system which uses a hollow fiber module. Therefore, it is an important technical problem to improve and secure the dependability of a hollow fiber module.

[0004] As an approach of detecting the leak defect of a hollow fiber, it is in the condition which soaked the hollow fiber in suitable liquids (water or alcoholic water solution) as an example, and the air of a predetermined pressure is supplied to the inside or an outside from the inside from the outside of the film of a hollow fiber, and the method of measuring the air flow rate in that case, and detecting the existence of leak is adopted.

[0005] In this approach, when passing air from the outside of the film of a hollow fiber to the inside, it is possible to specify the hollow fiber which has a leak defect by the size of the air transparency flow rate in a closure end face. In addition, it is possible to serve also as proof-pressure inspection and to perform air ** at this time by setting it as pressure extent for which a hollow fiber module is used.

[0006] Moreover, as the concrete detection approach, it was indicated by JP,2-14084,B, for example, and there is a method of making the air which contains a particle from the outside surface of a hollow fiber flow, passing a particle counter for the air attracted from opening, measuring [carry out reduced pressure suction,] the number of particles, such as dust in the suction air, and detecting the existence of a defect from opening of the terminal of each hollow fiber of a hollow fiber module.

[0007] Furthermore, as other examples, it was indicated by JP,53-134776,A, supply gas to the external surface of a hollow fiber, gas is made to reveal from the rejected region of the open end of the hollow fiber, and there is an approach the refraction phenomenon according to the outflow situation of the leakage gas detects the existence of a defect using an optical system.

[0008] And as the repair approach of the defect detected by the defective detection approach which was illustrated above, it was indicated by JP,53-134776,A etc., for example and, generally the approach of trickling the encapsulant equipped with the fluidity into the defective location of an opening end face, and closing it is adopted.

[0009] However, although it is effective as an approach of inspecting the condition of the hollow fiber module immediately after completion by the above inspection approaches, it is not detected by the

hollow fiber in such inspection, and this cannot be detected when there is a connotative film defect discovered when a pressure load repeats to the actual condition at the time of use.

[0010] that is, a defective part with the film connotative (potential) by the inspection approach by the first stage-static pressure -- detection (or it is made to leak) -- things are not made, but when this is used for a system as it is, a connotative defect will be discovered as an actual harm **** defect in the middle of actual operation. Therefore, durable inspection under the situation of having covered loads, such as a pressure made approximating to actual use about such a connotative defect, needed to be conducted.

[0011] Generally as a class of film defect, there are a thin thing, and film crushing and flat ** locally [thickness deviation and thickness], and it summarizes in Table 1 whether it is detectable by whenever [leak effect / of these defects], and the inspection approach by the first stage-static pressure.

[0012]

[Table 1]

欠陥モード	リークへの影響度		静圧による検査 方法で検出可能 な欠陥か
	初期耐圧	耐久耐圧	
偏肉	影響大	影響大	検出可能
膜厚の局所的に薄いもの	影響大	影響小	検出可能
膜つぶれ・偏平	影響中	影響大	検出不可能

Therefore, according to Table 1, it is impossible to detect a membranous defective part for the above-mentioned reason by the film crushing and to receive flatly and according to first stage-static pressure inspection approach.

[0013] When internal pressure (at the time [In the case of "internal-pressure filtration" which filters outside from the time of a back wash and the membranous inside in "external-pressure filtration" filtered from a membranous outside to the inside] of filtration) is applied during operation of an actual system, film crushing and the hollow fiber which the mechanism of leak generating set flatly was once crushed, and has deformed swell, and return to a normal gestalt, but when external pressure is added, it will be crushed again. By repeating this, fatigue by crookedness will occur to the part of film crushing, and, finally it will result in fracture. However, in the normal part which the defect of film crushing and flat ** has not generated, it is not crushed without a gestalt changing also with the repeat loads of internal pressure and external pressure, and a damage is not received.

[0014] Moreover, also when it has not clear film deformation but a certain film defect of a minute crease or flat ** like crushing, since it becomes filtration, a back wash or filtration, and the repeat of expansion of the hollow fiber itself and compression in the case of the repeat of a halt, there is an inclination membranous fracture becomes easy to generate.

[0015]

[Problem(s) to be Solved by the Invention] In order to obtain a more reliable hollow fiber module from the above thing, it is necessary to manufacture the hollow fiber module with which a defect does not exist at all, or to detect and specify the inspection approach of the manufactured hollow fiber module, and to repair it to the defect of the connotative film detected by adding not only static pressure-inspection but a repeat pressure load.

[0016] Therefore, while making it not generate a defect as much as possible in the improvement of a production process etc., as inspection, static pressure-inspection and proof-pressure durable inspection which covers a pressure load over a hollow fiber module repeatedly with the gestalt made

to approximate to real use are needed.

[0017] However, in order to make the defective parts of film crushing and flat ** leak by this proof-pressure durable inspection, the inspection time amount (count of a repeat of a pressure load) according to extent of that defect is needed. Although approaches, such as raising the temperature of the approach of shortening the time amount per 1 cycle of a pressure load and the inflow fluid at the time of inspection, are adopted in order to shorten this inspection time amount, compaction of large time amount cannot be desired.

[0018] For example, in a hollow fiber (it is the thing of a cut off molecular weight 50000 at polysulfone ultrafiltration membrane) with an outer diameter [of 1.4mm], and a bore of 0.8mm, it starts [in order to make a defect discover in proof-pressure durable inspection which performs the repeat for external pressure filtration 60 seconds for internal pressure filtration 60 seconds, need 2 to no less than 8 hours inspection time amount, and / great time amount and costs] an inspection process and was not economical per 1 cycle.

[0019] The place which it was made in order that this invention might solve the problem of the above-mentioned conventional technique, and is made into the purpose is in the method of detecting a connotative defect which cannot be detected in static pressure-inspection to indicate the inspection approach which can be detected with an easy configuration for a short time.

[0020]

[Means for Solving the Problem] If it is in this invention in order to attain the above-mentioned purpose Pressurize the periphery front face of the film of a hollow fiber, crush a membranous defective part, and membranous bore passage is made to blockade. It is characterized by specifying the hollow fiber by which a fluid is supplied to the bore passage of a hollow fiber from one opening edge of said hollow fiber, the fluid which passed through said bore passage in the opening edge of another side is detected, and a fluid is not detected as that to which a defective part exists in the film.

[0021] Moreover, load with the bundle of a hollow fiber into a tubed case, and it sets to the inspection approach of the hollow fiber module equipped with the closure section closed where opening of the terminal of the bundle of a hollow fiber is carried out in case both ends. Pressurize said interior of a case, crush the defective part of a hollow fiber, and membranous bore passage is made to blockade. It is characterized by detecting the part of said closure section where a fluid is supplied to a hollow fiber from one closure section of said hollow fiber module, the fluid which passed said hollow fiber in the closure section of another side is detected, and a fluid is not detected as a location of the opening terminal of a hollow fiber with which a defective part exists.

[0022] Therefore, it becomes possible to specify the hollow fiber equipped with the defective part which is crushed by pressurizing and blockades the bore passage of a hollow fiber.

[0023]

[Embodiment of the Invention] The inspection approach of the hollow fiber by this invention and a hollow fiber module and its equipment are explained based on the gestalt of implementation of illustration below.

[0024] Drawing 1 is the hollow fiber module 1 used as a subject of examination, and equips the interior of the housing case 2 with the hollow fiber 3. In the both ends of the housing case 2, where opening of the terminal is carried out, the closure of the terminal of a hollow fiber 3 is carried out by the closure sections 4a and 4b.

[0025] This hollow fiber module 1 is an internal pressure filtration method filtered outside from the membranous inside, and makes the fluid for filtration flow into the bore passage of a hollow fiber 3 either of the opening edges 5a and 5b of both ends, or by turns. The transparency fluid which penetrated the film flows out of the hollow fiber module 1 through the interior of the housing case 2 to the tap holes 6a and 6b.

[0026] The inspection approach of the hollow fiber module 1 of such a configuration is explained based on drawing 2. First, in the usual static pressure leak inspection which inspects the cutting section and the breakage of each hollow fiber 3 of the hollow fiber module 1 interior, when supplying tap hole 6a to pressurization air A3 like drawing 2 (a) and the cutting section and a breakage (leak part) are [this (tap hole 6b is closed by covering device material 6c.)] in either among each hollow fiber, transparency of remarkable air takes place from that part. This air will flow out of both opening edges

5a and 5b through the bore passage of this hollow fiber. It is possible to detect the existence of leak by measuring or detecting this flow rate.

[0027] The detection approach of the air which flows out of the opening terminal of each hollow fiber can be detected by making detection microtubule 10a of dynamic pressure 10 [a total of] illustrated approach the opening terminal of each hollow fiber of opening edge 5a. Moreover, it is possible also by checking visually whether by the detection approach of the air in the above-mentioned static pressure leak inspection approach, it does not depend on a measuring instrument, but water and a neutral detergent water solution are dropped at an opening terminal, and it is blown away.

[0028] Next, static pressure-inspection made into the technical problem of this invention explains the method of detecting a connotative defect which cannot be detected. In order to pressurize the periphery front face of each hollow fiber and to crush a membranous defective part by pressurizing the interior of the housing case 2 at a fixed pressure, covering device material 6c closes tap hole 6b, and pressurization air A3 is made to flow from tap hole 6a in drawing 2 (a).

[0029] Detection air A1 is supplied to the bore passage of each hollow fiber 3 from opening edge 5b in this condition. Drawing 2 (b) is drawing explaining the condition inside the pressurized hollow fiber module 1. Since each bore passage is secured, as for normal hollow fiber 3c, detection air A2 is flowing out of opening edge 5a of the opposite side. However, defective-part 3b is crushed with the pressure of pressurization air A3, hollow fiber 3a which has a defective part with defective-part 3b, such as film crushing, makes the bore passage blockade, and detection air A1 does not flow out of opening edge 5a of the opposite side.

[0030] It is possible to specify hollow fiber 3a which has a defective part by finding the hollow fiber into which an opening edge 5a front face is moved, and detection air is not flowing detection microtubule 10a of dynamic pressure 10 [a total of] which carried out point **.

[0031] Moreover, it is possible for it not to be limited to the approach by the dynamic pressure meter as an approach of detecting whether detection air flowing out of opening of each hollow fiber, and to adopt various approaches. For example, it is possible to use a hot wire anemometer instead of detection microtubule 10a, or to supply the detection air containing a particle which is indicated by Japanese Patent Application No. 4-316480, and to adopt the approach of detecting this particle optically etc. (the laser beam scan type particle detecting method).

[0032] And a reliable hollow fiber module can be obtained by short-time inspection by repairing hollow fiber 3a which has the detected defective part with adhesives etc.

[0033]

[Example] In order to check the effectiveness by the gestalt of the above-mentioned operation, the comparison with inspection by the inspection approach (pressurization inspection method) which applied this invention, and the inspection (durable inspection method) by the conventional approach was performed.

[0034] (Pressurization inspection method) One yarn of the hollow fiber which has the defective part of film crushing intentionally is made to mix in the hollow fiber module 1 (m [of effective length / 1], and film surface product 6m²) shown in drawing 2 (a), and it manufactures, and is 3kg/cm². Where pressurization air A3 is supplied Detection air A1 is supplied from opening edge 5b, and dynamic pressure 10 [a total of] detects the flow rate level of the detection air A2 which flows out by opening edge 5a of the opposite side.

[0035] The yarn of the hollow fiber which has a defective part was specified as a hollow fiber to which the flow rate level of the detection air A2 of opening edge 5a has opening in a low location, and repaired this hollow fiber.

[0036] After repairing, it is 70-degree C warm water to the hollow fiber module 1, respectively 2kg/cm² Although durable inspection which carries out a load repeatedly every 60 seconds was conducted so that it might become internal pressure and external pressure, generating of leak did not take place till after 60-hour progress.

[0037] The defective part of film crushing is certainly detected by short-time pressurization inspection, and, as for this, that a defect moreover did not exist in other hollow fibers means having been checked for a short time.

[0038] (Durable inspection method) In the semantics which performs the comparison with pressurization inspection, one yarn of the hollow fiber which has the defective part of film crushing

intentionally like the above is made to mix, and a hollow fiber module is manufactured.

[0039] To this hollow fiber module, it is 70-degree C warm water, respectively 2kg/cm² Durable inspection which carries out a load repeatedly every 60 seconds so that it may become internal pressure and external pressure was conducted. In the result, after 4 hours passed, generating of leak broke out from the defective part, and the yarn of the hollow fiber which has this defective part was specified as a hollow fiber to which the flow rate level of the detection air A2 of opening edge 5a has opening in a low location.

[0040] And after repairing the hollow fiber which has this defective part, when the same durable inspection as the above was conducted again, generating of leak did not take place till after 60-hour progress.

[0041] Although the defective part of film crushing is made to discover as a defect by durable inspection and this can be detected, time amount until it detects is long duration, and it is difficult to make a defective part discover certainly as a defect moreover. Therefore, in order to secure dependability equivalent to the pressurization inspection method by this invention, inspection of long duration is required.

[0042]

[Effect of the Invention] It becomes possible to certainly specify the hollow fiber equipped with the impossible connotative defect of detecting in static pressure-inspection, i.e., the defective part which is crushed by pressurizing and blockades the bore passage of a hollow fiber, by short-time inspection according to this invention, and it becomes possible to obtain a reliable hollow fiber and a hollow fiber module.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] a part of example of the hollow fiber module with which drawing 1 applies the inspection approach by this invention -- it is a cross-section cutting explanatory view.

[Drawing 2] Drawing 2 is the outline explanatory view of the defective inspection approach of a hollow fiber module.

[Description of Notations]

1 Hollow Fiber Module

2 Housing Case

3 Hollow Fiber

3a The hollow fiber which has a defective part

3b Defective part

3c A normal hollow fiber

4a, 4b Closure section

5a, 5b Opening edge

6a, 6b Tap hole

10 Dynamic Pressure Meter

A1, A2 Detection air

A3 Pressurization air

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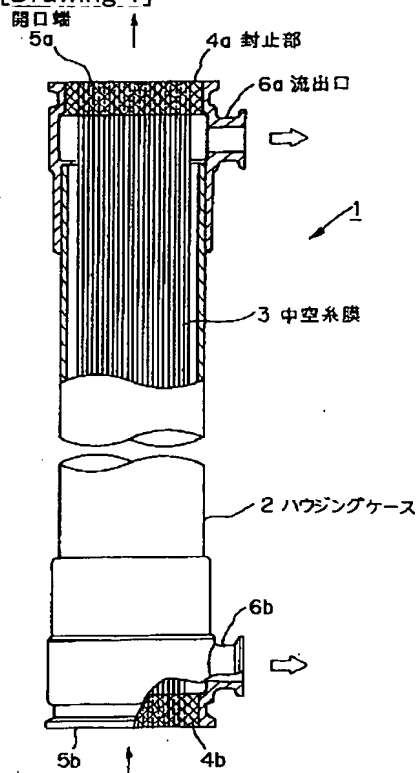
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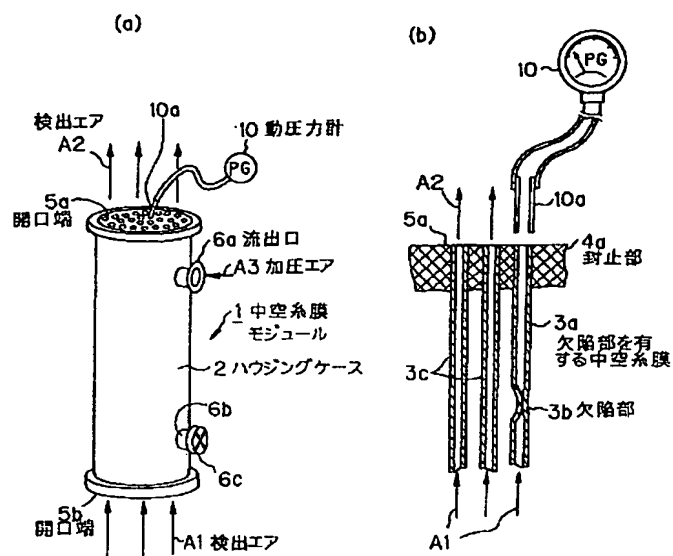
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DRAWINGS

[Drawing 1]



[Drawing 2]



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